TRANSACTIONS
OF THE
ROYAL SOCIETY OF NEW ZEALAND

ZOOLOGY

VOL. 5 NO. 13 FEBRUARY 10, 1965

Breeding Cycles and Pre-zoea Larva of *Petrolisthes elongatus* (Milne Edwards, 1837). (Crustacea, Decapoda)

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[*Received by the Editor, April 6, 1964.*]

Abstract

THE seasonal breeding cycle in *Petrolisthes elongatus* from Wellington Harbour, New Zealand, has been determined for 1962 and 1963, and related to the abundance of larvae in Wellington Harbour plankton samples. The pre-zoea larva is described.

INTRODUCTION

Petrolisthes elongatus is extremely abundant between the tide marks on nearly all rocky and stony beaches of New Zealand. The abundance of this anomuran "half-crab" makes it especially suitable for the determination of seasonal breeding cycles. For this study a restricted area of beach in Kau Bay, Wellington Harbour, was selected for routine sampling of adult crabs, and variations in the condition of mature females was related to the abundance of zoea larvae occurring in weekly plankton samples from Kau Bay.

With the zoea and megalopa larvae of *P. elongatus* now fully described (Wear, 1964b) this paper brings our knowledge of the life history of this species near to completion.

MATERIALS AND METHODS

A random sample of 500 adult crabs from Kau Bay, Wellington Harbour, was collected in the third week of each month from March, 1962, to December, 1963. The reproductive state of mature females was noted in the field, and the male to female sex ratio was calculated for each month. Females carrying eggs with larval eye-pigment were known to be within one week of liberating their larvae, and several of these were returned alive to the laboratory. Pre-zoea larvae were thus obtained when the eggs hatched.

Planktonic zoea larvae were obtained from Kau Bay, Wellington Harbour, using a 36 gauge two-foot diameter cone net towed in depths between one fathom and six fathoms for 20 minutes. The monthly mean abundance of larvae in the plankton samples was calculated.

Notes on the nomenclature of larval limbs and limb segments, and diagrammatic representation of coloured chromatophores, are given by Wear (1964a).

Published by the Royal Society of New Zealand, c/o Victoria University of Wellington, P.O. Box 196, Wellington.

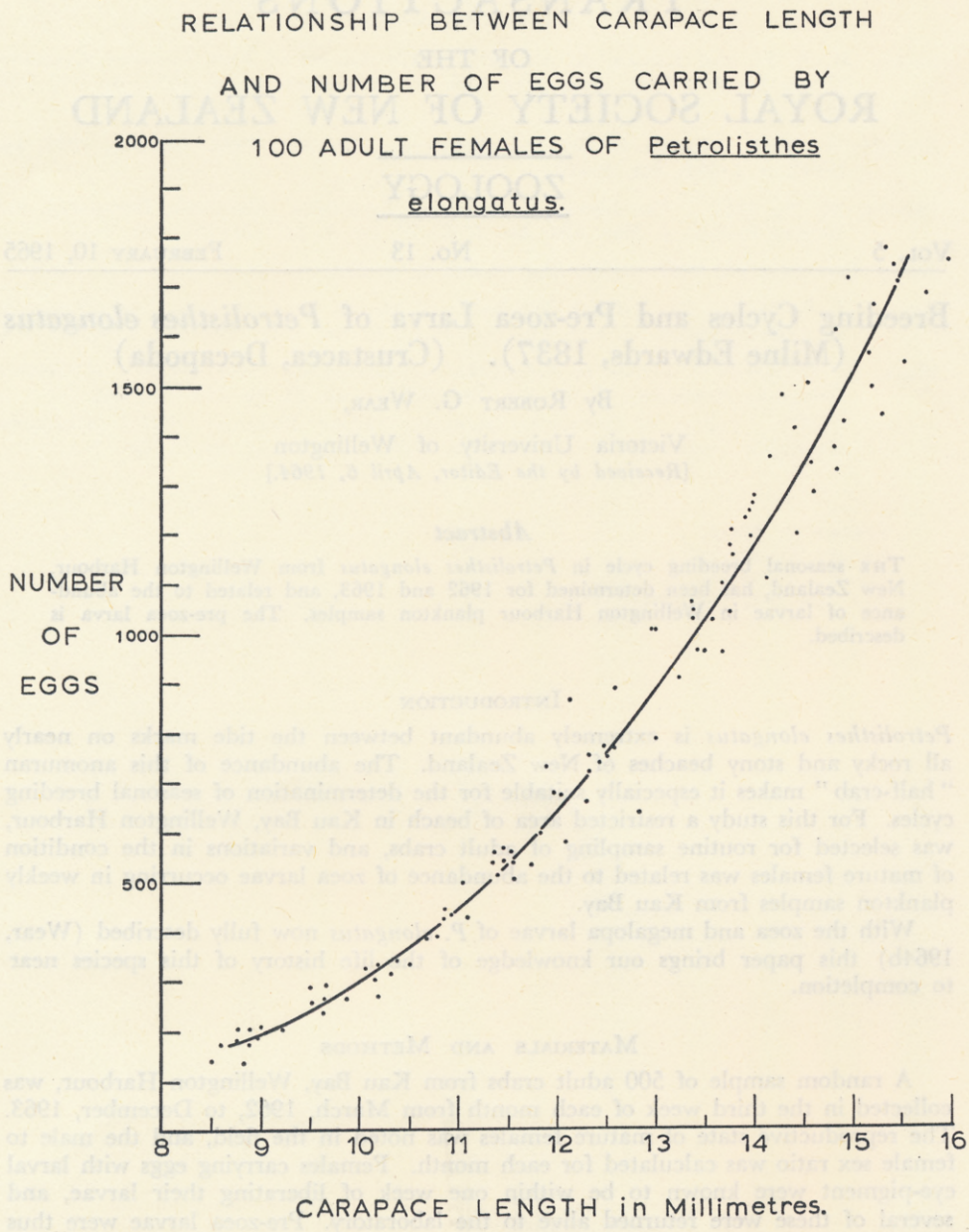

Fig. 1.—Relationship between Carapace Length and Number of Eggs carried by 100 adult females of *Petrolisthes elongatus*.

Breeding Cycle

Female crabs were found to be sexually mature when their carapace length exceeded 8.5mm, and these carried about 200 eggs (Fig. 1). The largest female crabs (carapace length 15mm to 16mm) carried from 1,500 to 1,750 eggs. The relationship between carapace length and number of eggs carried is shown in Fig. 1.

Egg laying begins in July, and by mid-July about 40% of mature females are in berry. New eggs are reddish-purple in colour, ovoid in shape, and measure 0.65mm x 0.40mm. Each egg is attached to a pleopod hair of the female by a chitinous strand. By mid-September about 90% of females are in berry, and of these about 20% possess eye-pigment. In late September, a few first stage larvae were recorded in plankton samples (Fig. 2). The incubation period is therefore from six to eight weeks. In October and November the percentage of females in berry decreased slightly, but about 60% of the berried females possessed eye-pigmented eggs. In December, 1962, and January, 1963, the percentage of females in berry fell sharply, and in February and March few females were in berry, but all of these had eye-pigmented eggs (Fig. 2).

During the incubation period females were seen removing moribund eggs with their fifth chelate pereiopods. Within one or two days of hatching, eggs measure 1.0mm x 0.75mm, are reddish in colour, and semi-transparent. The eyes of the larva are clearly visible at this stage, and scattered red and orange chromatophores indicate the position of the larval abdomen. The yolk is still large and visible as a brown pigmented mass (Fig. 3, A).

Females in late berry had their ovaries gravid with the next batch of eggs. It is therefore probable that at least two broods of eggs are laid yearly by most female crabs.

During the months when egg laying and incubation is in progress (August to December) the male to female sex ratio indicated a higher percentage of female crabs above low tide level (Fig. 2). This suggests that there may be a migration of females towards the upper limit of the inter-tidal zone, possibly to expose their developing eggs to longer periods of warmer atmospheric temperatures. It is only in the late autumn and winter months when incubation is not in progress that the sex ratio is approximately equal (Fig. 2).

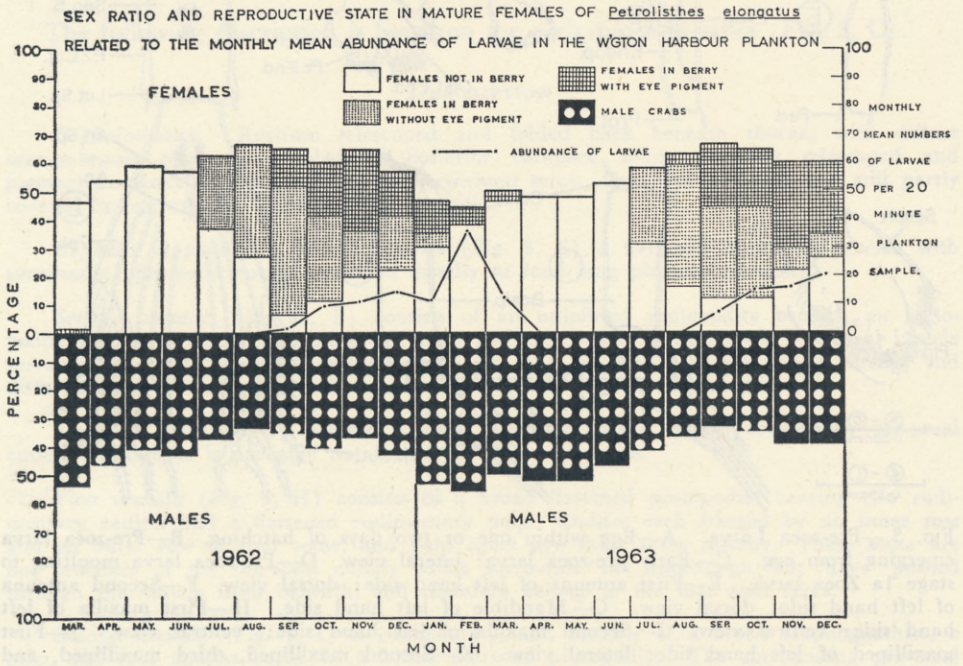
SEX RATIO AND REPRODUCTIVE STATE IN MATURE FEMALES OF Petrolisthes elongatus
RELATED TO THE MONTHLY MEAN ABUNDANCE OF LARVAE IN THE WGTON HARBOUR PLANKTON
FEMALES
FEMALES NOT IN BERRY
FEMALES IN BERRY WITH EYE PIGMENT
FEMALES IN BERRY WITHOUT EYE PIGMENT
MALE CRABS
ABUNDANCE OF LARVAE
MONTHLY MEAN NUMBERS OF LARVAE PER 20 MINUTE PLANKTON SAMPLE.
PERCENTAGE
MALES
1962
MALES
1963
MAR. APR. MAY. JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY. JUN. JUL. AUG. SEP. OCT. NOV. DEC.
MONTH

FIG. 2.—Sex ratio and reproductive state in mature females of *Petrolisthes elongatus* related to the monthly mean abundance of larvae in the Wellington Harbour plankton, 1962–1963.

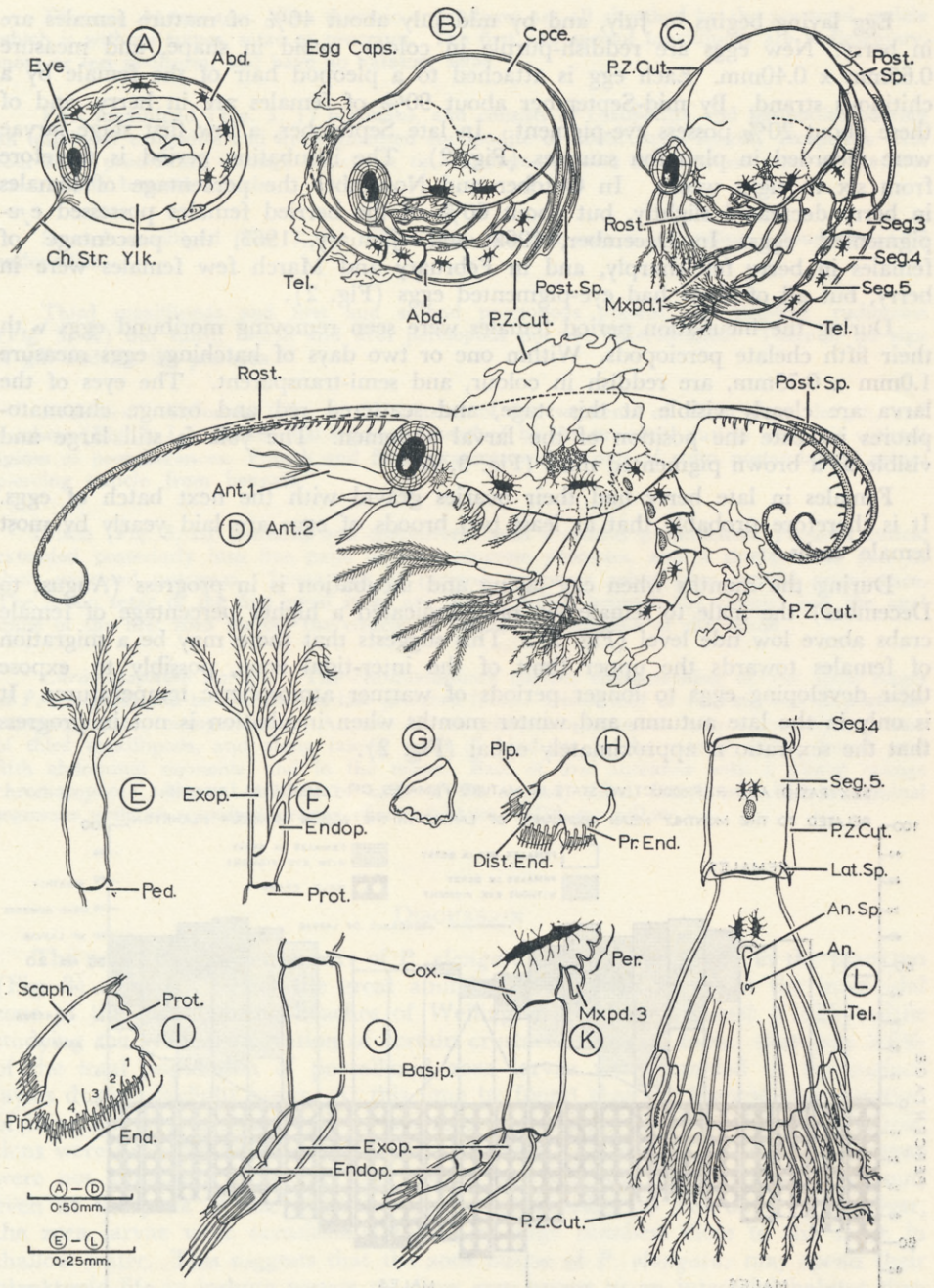

Fig. 3.—Pre-zoea Larva. A—Egg within one or two days of hatching. B—Pre-zoea larva emerging from egg. C—Early pre-zoea larva: lateral view. D—Pre-zoea larva moulting to stage 1a Zoea larva. E—First antenna of left hand side: dorsal view. F—Second antenna of left hand side: dorsal view. G—Mandible of left hand side. H—First maxilla of left hand side: ventral view. I—Second maxilla of left hand side: ventral view. J—First maxilliped of left hand side: lateral view. K—Second maxilliped, third maxilliped, and pereiopod buds of left hand side: lateral view. L—Fifth abdominal segment and telson: ventral view.

Abbreviations for Figure 3.—Abd., Abdomen; An., Anus; An. Sp., Aanal Spine; Ant. 1, First Antenna; Ant. 2, Second Antenna; Basip., Basipodite; Ch. Str., Chitinous Strand; Cox., Coxopodite; Cpce., Carapace; Dist. End., Distal Endite; Egg Caps., Egg Capsule; End. 1–4, Endites 1 to 4; Endop., Endopodite; Exop., Exopodite; Eye, Eye; Lat. Sp., Lateral Spine; Mxpd. 3, Third Maxilliped; Ped., Peduncle; Per., Periopods; Plp., Palp; Post. Sp., Posterior Spine; Pr. End., Proximal Endite; Prot., Protopodite; P.Z. Cut., Pre-zoeal Cuticle; Rost., Rostrum; Scaph., Scaphognathite; Seg. 3–5, Abdominal Segments 3 to 5; Tel., Telson; Ylk., Yolk.

PRE-ZOEA LARVA

Pre-zoea larvae, hatched from eggs in the laboratory, rupture the egg capsule by violent flexures of the abdomen (Fig. 3, B). As in the majority of Decapoda, these larvae are characterised by having biramous, more or less pediform maxillipeds without natatory setae. In the laboratory the duration of the pre-zoeal stage varied between 60 minutes and 90 minutes. The comparatively short duration of this larval stage is the probable reason for its absence from plankton samples.

At first the rostrum is telescoped with its tip folded back under the basal segments of the thoracic appendages, while its greater length is invaginated and telescoped into an " S " shape extending back beneath the carapace above the mid-gut. The invaginated section may be flexed either from left to right or from right to left in dorsal view. The posterior carapace spines are telescoped and curled downwards and forwards (Fig. 3, C). About 30 minutes after hatching the rostrum is incompletely extended, and curled downwards at the tip. The posterior carapace spines are also only partly extended. About one hour after hatching the rostrum and posterior carapace spines are almost completely uncurled, and the pre-zoea larva starts to shed its cuticle in moulting to the first true zoeal stage (Fig. 3, D).

The following description is based on the early pre-zoea larva (Fig. 3, C).

DESCRIPTION

Cephalothorax. Rostrum telescoped and folded back beneath thorax, with diffuse orange-brown pigmentation distally. Posterior carapace spines similarly telescoped and pigmented. Rostrum and posterior spines without setae. Carapace wrinkled and still partly covered by egg capsule. Eyes large and sessile.

Cephalic Appendages. First antenna (Fig. 3, E) a flattened unjointed process with surrounding pre-zoeal cuticle extended distally as four long plumose processes.

Second antenna (Fig. 3, F) consists of an unjointed protopodite bearing an endopodite and exopodite. Endopodite less than half the length of exopodite. Pre-zoeal cuticle surrounding second antenna extended into six long plumose processes along medial and distal margins of exopodite, and one terminal plumose process on endopodite.

Mandible (Fig. 3, G) without a palp, and with molar surface covered by pre-zoeal cuticle. Mandible is probably not functional in the pre-zoea.

First maxilla (Fig. 3, H) consists of a broad flattened protopodite bearing two rudimentary endites and a flattened rudimentary palp. Endites each fringed by an inner row and an outer row of four setae, and palp bears five short setae distally. These setae are not processes of the pre-zoeal cuticle which surrounds the appendage, but have pushed through the cuticle from beneath, and therefore belong to the first zoea larva.

Second maxilla (Fig. 3, I) is rudimentary, and consists of a broad scaphognathite, a palp, and four endites borne by a broad flattened protopodite. The surrounding pre-zoeal cuticle is not thrown into processes, and the simple setae visible beneath the cuticle are of the first zoeal stage.

Thoracic Appendages. The thoracic appendages are all sheathed by the pre-zoeal cuticle which is without spines, setae or processes. The first and second maxillipeds are rudimentary, more or less pediform, and have no natatory setae.

First maxilliped (Fig. 3, J) biramous, and consists of coxopodite and basipodite bearing an unjointed exopodite and five-segmented endopodite of about equal length. Exopodite with four setae protruding through cuticle at tip. Endopodite with six terminal setae of the first zoea visible beneath cuticle.

Second maxilliped (Fig. 3, K) differs from the first only in possessing a four-segmented endopodite.

Third maxillipeds and first and second pereiopods present as bud-like rudiments (Fig. 3, K) but third, fourth and fifth pereiopods not yet differentiated. There is no sign of gill buds in the pre-zoea.

Abdomen. Abdomen (Fig. 3, C) consists of five segments of about equal length, and a telson (Fig. 3, L). Abdominal segments sheathed by the pre-zoeal cuticle which is without spines or protuberances. Fourth and fifth segments with a pair of stout posterolateral spines piercing cuticle from beneath.

Telson (Fig. 3, L) flattened and spatuliform with a central prominence. Pre-zoea cuticle extended posteriorly into five pairs of long plumose processes, and a single outer pair of short unarmed processes. Inner pair of plumose processes arises from central prominence. The telson setae of the first zoeal stage are clearly visible beneath the cuticle, and the anal spine of the first zoea pierces the cuticle in the ventral midline of the telson.

Chromatophore Pattern. The chromatophore pattern characterising all the zoeal stages of *P. elongatus* can be seen in the late pre-zoea larva. Distal half of rostrum and of posterior carapace spines orange-brown. A pair of red chromatophores at base of mandibles, base of third maxillipeds, and along lateral walls of hind-gut in the second, third, fourth and fifth abdominal segments, and in the telson. Base of first antennae with a paired orange chromatophore. Ventral midline of each of the second, third, fourth and fifth abdominal segments with an unpaired orange chromatophore. Mid-gut yellow.

DISCUSSION

The relatively small numbers of *P. elongatus* zoea larvae found in the plankton (Fig. 2) does not reflect the great abundance of adults found in the inter-tidal zone of the neighbouring beaches of Wellington Harbour. Russel (1925) while studying the vertical migration of certain crustacean larvae, found that only 2.6% of the total population of porcellanid zoea larvae were sampled in the surface layers during daylight hours. At this time he found that the highest concentration of these larvae was at a depth of ten to thirty metres. However Russel's observations were probably not based on intertidal porcellanid species. *P. elongatus* larvae were not abundant in deeper tows (below six fathoms) in Wellington Harbour, even at the peak of the liberation period (November to February). However, the zoea larvae were occasionally found in large numbers close to the shore in shallow water. This suggests that the zoea larvae of *P. elongatus* may spend their planktonic life in inshore waters to allow easy access to an intertidal habitat during the megalopa or early juvenile crab stages.

The pre-zoea larva of *P. elongatus* is similar to that of *Porcellana longicornis* described by Gurney (1942) and Lebour (1943), and that of *Petrolisthes rufescens* described by Gohar and Kholy (1957). It is readily separated from these only by the chromatophore pattern.

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